TMDLS FOR NITRATE AND PHOSPHORUS IN ROLLING FORK

(REACH 11140109-919)

FINAL
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Prepared by

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

This report presents TMDLs for nitrate and total phosphorus for Rolling Fork (reach 11140109-919) in southwestern Arkansas. Rolling Fork is located within the Ouachita Mountains ecoregion and is approximately 98% forest and pasture. Rolling Fork has a drainage area of approximately 51.8 square miles at the downstream end of the impaired reach. Rolling Fork flows into DeQueen Lake.

This stream reach was cited as not supporting its designated use of aquatic life according to the final 2002 Arkansas 303(d) list and the draft 2004 Arkansas 303(d) list. Based on the 303(d) listing and a 1998 study by the Arkansas Department of Environmental Quality (ADEQ), the suspected source of impairment is an industrial point source (Tyson Foods at Grannis).

Historical monitoring data for nitrate and phosphorus have been collected by ADEQ in Rolling Fork at two stations, RED0030 and RED0058. These data were analyzed for long term trends and relationships between concentration and hydrologic conditions. These analyses showed that most of the exceedances occur during late summer, dry weather conditions.

Arkansas has no numeric water quality standard for nitrate. A target nitrate concentration of 10 mg/L was used in the TMDL as recommended in ADEQ's 1998 study of Rolling Fork. For total phosphorus, a target concentration of 0.1 mg/L was used based on the stream guideline established in the previous version of Arkansas Regulation No. 2.

The TMDLs in this report were developed for average annual conditions because aquatic life impairments typically occur as a result of long term exposure to elevated nutrient concentrations rather than short term increases in nutrient concentrations. Both TMDLs were developed using a simple mass balance approach assuming conservative mixing.

Wasteload allocations (WLAs) were developed for the point source discharge. The allowable point source loads were based on the design flow for the Tyson facility and concentrations of 10 mg/L of nitrate (recommended in the 1998 ADEQ study) and 2 mg/L of total phosphorus (Tyson's permit limit that will become effective in 2007). Based on recent effluent concentrations of nitrate and total phosphorus, point source reductions will be required for both nitrate and total phosphorus.

An explicit margin of safety (MOS) of 10% was incorporated in each of the TMDLs. The allowable nonpoint source loads were calculated as the difference between the assimilative capacity of the stream and the sum of the WLA and MOS. The allowable nonpoint source loads were compared with existing nonpoint source loads, which were estimated based on average annual stream flow and average concentrations of nitrate and total phosphorus from the Cossatot River (because all of the water quality data for Rolling Fork is influenced by a point source discharge). These calculations indicated that existing loads are smaller than allowable loads; no nonpoint source reductions are required.

The TMDLs are summarized in Table ES.1.

Table ES.1. Summary of nitrate and phosphorus TMDLs for Rolling Fork.

	Allowable loadings (lbs/day)	
	Nitrate	**Total Phosphorus**
WLA for point source	72	14.4
LA for nonpoint sources	5351	39.8
MOS (10%)	602	6.0
TMDL	6025	60.2

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1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for nitrate and total phosphorus for the Rolling Fork in western Arkansas near Grannis. This stream reach was cited as not supporting its designated use of aquatic life according to the final 2002 Arkansas 303(d) list (Environmental Protection Agency (EPA) 2003) and the draft 2004 Arkansas 303(d) list (Arkansas Department of Environmental Quality (ADEQ) 2005). The sources of contamination and causes of impairment from the 2004 303(d) listing are shown in Table 1.1. The TMDLs in this report address impairments due to nitrates and total phosphorus, but not other causes of impairment (copper).The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and the EPA's regulations in 40 CFR 130.7.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern. The LA is the load allocated to nonpoint sources and natural background. The MOS is a percentage of the TMDL that takes into account any lack of knowledge concerning the relationship between pollutant loadings and water quality.

Table 1.1. 303(d) listing for the stream reach in this task order (ADEQ 2005).

Stream Name and Reach No.	Impaired Use	Sources	Causes	Category	Priority
Rolling Fork 11140109-919	Aquatic life	Industrial point source	Nitrate, total phosphorus, copper	5A	High

2.0 BACKGROUND INFORMATION

2.1 General Information

The study area for the TMDL in this report is part of the Rolling Fork watershed near Grannis in western Arkansas (see Figure A.1 located in Appendix A). Rolling Fork drains in a generally southerly direction and forms DeQueen Lake downstream of the impaired reach. The impaired portion of Rolling Fork starts upstream of an unnamed tributary near Grannis and extends approximately 14 miles downstream to the confluence with Robinson Creek.

The Rolling Fork watershed is in the Ouachita Mountains ecoregion. The Rolling Fork watershed is also part of ADEQ Planning Segment 1C and US Geological Survey (USGS) Hydrologic Unit 11140109. The drainage area for Rolling Fork at its confluence with Robinson Creek is approximately 52 square miles.

2.2 Land Use

Land use data for the Rolling Fork watershed were obtained from the GEOSTOR database, which is maintained by the Center for Advanced Spatial Technology (CAST) at the University of Arkansas in Fayetteville. These data were based on satellite imagery from 1999. The spatial distribution of these land uses is shown on Figure A.2 (located in Appendix A) and land use percentages are shown in Table 2.1. These data indicate that the study area is comprised of approximately 76% forest and approximately 23% pasture.

Table 2.1. Land use percentages for the study area.

Land use	Percentage of study area
Forest	76.2%
Pasture	22.6%
Urban	1.0%
Water	0.2%
Total	100.0%

2.3 Hydrology

There are no recent published stream flow data for Rolling Fork upstream of DeQueen Lake. The USGS has published daily stream flow data for the Cossatot River near Vandervoort (Gage No. 07340300), which is adjacent to the Rolling Fork watershed and has similar land use and topography. The average flow for this gage is 191 cfs, which is based on a period of record of 1967 through 2004. The drainage area for this gage is 89.6 square miles.

2.4 Water Quality Standards

2.4.1 Designated Uses

Designated uses and water quality standards for Rolling Fork are given in Arkansas Regulation No. 2 (Arkansas Pollution Control and Ecology Commission (APCEC) 2004a). The designated uses for Rolling Fork are primary and secondary contact recreation; industrial and agricultural water supply; and perennial fishery (where the drainage area is at least 10 square miles). The domestic water supply use has been removed for Rolling Fork from the unnamed tributary at Grannis down to DeQueen Lake.

2.4.2 Phosphorus

Arkansas has the following narrative water quality standard applicable to phosphorus (APCEC 2004a):

> "Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients are dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any established, numeric water quality standard, the waterbody will be determined to be impaired by nutrients."

Although Arkansas does not have an instream water quality standard for phosphorus, the following numeric limits apply to point sources discharging into impaired waterbodies:

> "All point source discharges into the watershed of waters officially listed on Arkansas' impaired waterbody list (303d) with phosphorus as the major cause shall have monthly average discharge permit limits no greater than those listed below. Additionally, waters in nutrient surplus watersheds as determined by Act 1061 of 2003 Regular Session of the Arkansas 84th General Assembly and subsequently designated nutrient surplus watersheds may be included under this Reg. if point source discharges are shown to provide a significant phosphorus contribution to waters within the listed nutrient surplus watersheds.

Facility Design Flow	Total Phosphorus discharge limit
15 MGD or more	Case by case
3 to <15 MGD	1.0 mg/L
1 to <3 MGD	2.0 mg/L
0.5 to <1.0 MGD	5.0 mg/L
<0.5 MGD	Case by case

> "For discharges from point sources which are greater than 15 MGD, reduction of phosphorus below 1 mg/L may be required based on the magnitude of the phosphorus load (mass) and the type of downstream waterbodies (e.g., reservoirs, Extraordinary Resource Waters). Additionally, any discharge limits listed above may be further reduced if it is determined that these values are causing impairments to special waters such as domestic water supplies, lakes or reservoirs or Extraordinary Resource Waters."

2.4.3 Nitrate

Arkansas does not have a numeric water quality standard for nitrate. ADEQ conducts their assessment for streams using a criterion of 10 mg/L to protect the designated use of domestic water supply.

2.4.4 Antidegradation

As specified in EPA's regulations at 40 CFR 130.7(b)(2), applicable water quality standards include antidegradation requirements. Arkansas' antidegradation policy is listed in Sections 2.201 through 2.204 of Regulation No. 2. These sections impose the following requirements:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

2.5 Nonpoint Sources

In the 303(d) listing for Rolling Fork (ADEQ 2005), nonpoint sources were not identified as a significant source of nutrients causing impairment. During storms, runoff from pastures probably contributes some nitrate and phosphorus loading above background levels.

2.6 Point Sources

Point source discharges in the study area were identified using EPA's Permit Compliance System (PCS) web site (EPA 2005). According to PCS, there is one facility in the study area with a point source discharge that is permitted through the National Pollutant Discharge Elimination System (NDPES). The location of this facility, the Tyson Foods Grannis Facility, is shown on Figure A.3.

The Tyson Foods Grannis Facility currently does not have an effective permit limit for either nitrate or phosphorus. A permit limit of 2 mg/L for total phosphorus will become effective in 2007. The facility's permit currently requires monitoring and reporting of nitrate and phosphorus concentrations. Based on the data available in PCS to date (for December 2004 through July 2005), average reported effluent concentrations for nitrate and total phosphorus are 17.4 mg/L and 14.2 mg/L, respectively. The design flow for this facility is 0.864 MGD. Tyson discharges to a small unnamed tributary that flows into Rolling Fork within a short distance.

2.7 Previous Water Quality Study

During the mid 1990's, ADEQ conducted a study to evaluate the effect of discharges from the Tyson Grannis facility on Rolling Fork (ADEQ 1998). This study included collection of water quality data, physical data, and biological data. The study examined diurnal dissolved oxygen (DO), periphyton, and macroinvertebrate and fish populations for indications of stream impairment. Larger swings of diurnal DO were observed downstream of the effluent tributary, but no standards violations were observed. Qualitative observations of periphyton found more downstream of the effluent tributary. No impairment was indicated by the macroinvertebrate population, but this was probably due to the lack of a good reference site. The fish population had the same metrics upstream and downstream. A larger population of yellow bullheads downstream indicated nutrient enrichment.

3.0 EXISTING WATER QUALITY

3.1 General Description of Data

Nitrate and phosphorus data have been collected by ADEQ at approximately monthly intervals for two locations on Rolling Fork within the study area. ADEQ Station RED0058 is located in the impaired reach just downstream of the confluence with the Tyson Foods effluent tributary. ADEQ Station RED0030 is also located in the impaired reach and is approximately 4 miles downstream of the Tyson Foods effluent tributary confluence. The locations of the monitoring stations are shown on Figure A.3 in Appendix A. Data from these stations were obtained from the ADEQ web site. Time series plots of the nitrate+nitrite and total phosphorus data are shown in Appendix B and summary statistics are presented in Table 3.1. Comparing the data for Stations RED0058 and RED0030, concentrations of nitrate and phosphorus tend to be higher at the station just downstream of the point source discharge (RED0058).

Table 3.1. Summary of historical nutrient data for Stations RED0058 and RED0030.

ADEQ Station	Station Description	Parameter	Period of Record	Statistics			
				No.	Min.	Max.	Avg.*
RED0058	Rolling Fork west of Grannis, AR	Nitrate+nitrite, mg/L	3/27/00 - 9/13/05	67	0.23	24.6	4.41
		Total Phosphorus, mg/L	3/27/00 - 9/13/05	64	0.043	22.7	5.17
RED0030	Rolling Fork west of Gillham, AR	Nitrate+nitrite, mg/L	1/22/91 - 9/13/05	154	<0.01	43.7	2.22
		Total Phosphorus, mg/L	1/22/91 - 9/13/05	154	<0.02	11.5	1.49

*When calculating averages, half the detection level was used for data points reported as below detection level.

3.2 Seasonal Patterns

Neither the narrative criteria for nutrients nor the numerical guideline for phosphorus vary seasonally. Seasonal variations in existing water quality may provide additional insight into the causes of water quality impairment. Seasonal plots of the data for nitrate + nitrite and total

phosphorus are shown in Appendix C. These plots do show some seasonal variability; this variability may be attributed to seasonal variations in stream flow.

3.3 Relationships with Flow

Plots of nitrate + nitrite and total phosphorus versus stream flow were developed to examine potential correlations (Figures D.1-D.6 in Appendix D). Flow data for Rolling Fork were not available, so flow data from a nearby USGS station (Cossatot River near Vandervoort, AR) were used. In general, the highest concentrations occurred at low flow conditions.

4.0 TMDL DEVELOPMENT

4.1 Determination of Critical Conditions

EPA's regulations at 40 CFR 130.7 requires the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standards. Aquatic life impairments typically occur as a result of long term exposure to elevated nutrient concentrations rather than short term increases in nutrient concentrations. These nutrient TMDLs were developed for average annual conditions. The most obvious result of nutrients is algal blooms. When the algae die, the resultant biological oxygen demand consumes oxygen, which adversely affects aquatic life. The effect occurs in a short time but the build-up of nutrients and the conditions to start the algal bloom may occur over an extended time.

4.2 Establishing the Water Quality Target

As mentioned in Section 2.4, Arkansas has no numeric water quality standards for nitrate or phosphorus. ADEQ's special study for Rolling Fork (ADEQ 1998), recommended an effluent limitation of 10 mg/L for nitrate for the industrial point source discharge located in the impaired reach. Based on this recommendation, the target concentration (i.e., the endpoint) for this nitrate TMDL was 10 mg/L. At the time when this reach of Rolling Fork was first added to the 303(d) list for phosphorus, Arkansas Regulation No. 2 contained a numeric guideline for total phosphorus of 0.1 mg/L for streams. Although the current version of Regulation No. 2 no longer includes that guideline, it is still considered a reasonable benchmark for evaluating phosphorus levels in streams for the protection of aquatic life. The total phosphorus concentration of 0.1 mg/L was used as the target concentration, or numeric endpoint, for this phosphorus TMDL.

4.3 TMDL

The first step in developing the components of the nitrate and phosphorus TMDLs was to calculate the assimilative capacity for the segment. The assimilative capacity for the segment

was calculated by simply multiplying the target concentration (10 mg/L for nitrate or 0.1 mg/L for phosphorus) by the total flow in the stream for the segment and the appropriate conversion factor. The total flow in the segment was calculated as the average annual ambient flow from the watershed plus the design flow of the point source discharge. The average annual ambient flow for the segment was estimated as the average annual flow per unit area for the USGS gage on the Cossatot River near Vandervoort (2.13 cfs per square mile) times the drainage area of the segment (51.8 square miles). This resulted in average annual flow rate of 110 cfs, or 71.4 MGD. Including the design flow from the point source discharge (0.864 MGD), the total average annual flow for the segment is 72.2 MGD. When this total flow was multiplied by the target concentrations, the resulting values for assimilative capacity were 6,025 lbs/day of nitrate and 60.2 lbs/day of total phosphorus. Each TMDL was set equal to the assimilative capacity.

4.4 Margin of Safety

The next step was to account for the MOS. Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for lack of knowledge concerning the relationship between pollutant loadings and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. For these TMDLs, 10% of the assimilative capacity (i.e., 602 lbs/day of nitrate and 6.0 lbs/day of total phosphorus) was set aside as an explicit MOS. In addition to the explicit MOS, these TMDLs also include an unquantified implicit MOS due to the calculation of loads assuming that the point source is discharging at design capacity instead of at a typical flow rate.

4.5 Wasteload Allocations

After subtracting the MOS from the TMDL, allowable point source loads were calculated. For nitrate, an effluent concentration of 10 mg/L was used based on the recommendation in the ADEQ study of Rolling Fork (ADEQ 1998). For total phosphorus, an effluent concentration of 2 mg/L was used because that is the permit limit that will become effective for the Tyson facility in 2007. The point source loads were calculated as the design

flow (0.864 MGD) multiplied by the effluent concentrations and the appropriate conversion factor. The resulting loads were 72 lbs/day of nitrate and 14.4 lbs/day of total phosphorus. The allowable effluent concentrations and loads are shown in Table 4.1.

Table 4.1. Allowable point source concentrations and loads.

	Flow Rate (MGD)	Concentrations (mg/L)		Loads (lbs/day)	
		Nitrate	Total Phosphorus	Nitrate	Total Phosphorus
Tyson Foods Grannis Facility (AR0003018)	0.864	10	2	72	14.4

Based on averages of recent effluent concentrations discussed in Section 2.6 (17.4 mg/L of nitrate and 14.2 mg/L of total phosphorus), the Tyson facility will need to reduce its effluent concentrations of nitrate and total phosphorus to comply with these TMDLs.

4.6 Load Allocations

The LAs for nonpoint source loading from the watershed was calculated as the remaining available load after the MOS and WLA were subtracted from the TMDL. The LAs were calculated to be 5,351 lbs/day of nitrate and 39.8 lbs/day of total phosphorus.

In order to calculate percent reductions that would be needed for nonpoint source loads, the existing nonpoint source loads were calculated based on estimates of average ambient concentrations of nitrate and total phosphorus. Because ADEQ has no water quality monitoring stations on Rolling Fork upstream of the point source discharges, observed data from ADEQ Station RED0022 (Cossatot River west of Lockesburg) were used to estimate concentrations for nonpoint source inflow to Rolling Fork. Average concentrations of nitrate and total phosphorus at RED0022 were 0.21 mg/L and 0.060 mg/L respectively. These concentrations were multiplied by the average annual ambient flow for the segment (71.4 MGD) and the appropriate conversion factor. This yielded existing nonpoint source loads of 125 lbs/day of nitrate and 35.7 lbs/day of total phosphorus. Both of these existing nonpoint source loads are smaller than the allowable nonpoint source loads; no nonpoint source reductions are necessary.

The LAs and other components of the TMDLs are summarized in Table 4.2.

Table 4.2. Summary of nitrate and phosphorus TMDLs for Rolling Fork.

	Allowable loadings (lbs/day)	
	Nitrate	**Total Phosphorus**
WLA for point source	72	14.4
LA for nonpoint sources	5351	39.8
MOS (10%)	602	6.0
TMDL	6025	60.2

4.7 Future Growth

Compliance with these TMDLs for nitrate and phosphorus is based on keeping concentrations in the stream below the target concentrations rather than keeping the loads in the stream below a certain amount. The assimilative capacity of the stream will increase as the amount of flow in the stream increases. Increases in flow will allow for increased loadings of nitrate and phosphorus to Rolling Fork. Future growth for existing or new point sources discharging to Rolling Fork is not limited by this TMDL as long as the point source(s) do not cause instream concentrations of nitrate and phosphorus to exceed the target concentrations of 10 mg/L and 0.1 mg/L, respectively. At this time the instream criteria are the water quality targets established in Section 4.2. In the future, the instream criteria may be set by an addition of a numeric criteria to the standard or other values set by a nutrient criteria setting procedure by ADEQ.

5.0 MONITORING AND IMPLEMENTATION

In accordance with Section 106 of the federal Clean Water Act and under its own authority, ADEQ has established a comprehensive program for monitoring the quality of the State's surface waters. ADEQ collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for long term trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters which is published as the 2002 Arkansas Integrated Water Quality Monitoring and Assessment Report (ADEQ 2002).

Point source reductions for this TMDL will be implemented through the NPDES permitting program, which is administered by ADEQ.

6.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, this TMDL was prepared under contract to EPA. After development of the draft version of this TMDL, EPA prepared a notice seeking comments, information, and data from the general public and affected public. Comments were submitted during the public comment period and this TMDL has been revised accordingly. Responses to these comments are included in Appendix E. EPA has transmitted the revised TMDL to ADEQ for implementation and for incorporation into ADEQ's current water quality management plan.

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